

FLOOD INSURANCE STUDY



**DARKE COUNTY,
OHIO**
UNINCORPORATED AREAS



SEPTEMBER 29, 1989



Federal Emergency Management Agency

COMMUNITY NUMBER - 390137

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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FLOOD INSURANCE STUDY

DARKE COUNTY, UNINCORPORATED AREAS, OHIO

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Unincorporated Areas of Darke County, Ohio, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers (COE) (the Study Contractor) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. EMW-86-E-2226, Project Order No. 15. This study was completed in June 1987.

The hydrologic and hydraulic analyses for the Middle Fork East Fork Whitewater River were taken from the Flood Insurance Study for Wayne County, Indiana (Reference 1).

1.3 Coordination

In December 1985, streams requiring detailed study were identified at a meeting attended by representatives of the Study Contractor, FEMA, and Darke County.

On November 16, 1988, the results of this Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Darke County, Ohio. The area of study is shown on the Vicinity Map (Figure 1). The incorporated areas within the county were excluded from this study.

Flooding caused by overflow of Greenville Creek, Swamp Creek, and the Middle Fork East Fork Whitewater River was studied in detail.

Areas having low development potential or minimal flood hazards were previously studied using approximate analyses. The results were shown on the Flood Hazard Boundary Map for Darke County, Ohio (Reference 2) and are incorporated into this Flood Insurance Study.

The areas studied were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through June 1992. The scope and methods of study were proposed to and agreed upon by FEMA and Darke County.

2.2 Community Description

Darke County occupies about 600 square miles in west-central Ohio along the Indiana border. The county is bordered by Mercer County, Ohio, on the north; Shelby and Miami Counties, Ohio, on the east; Montgomery and Preble Counties, Ohio, on the south; and Wayne, Randolph, and Jay Counties, Indiana, on the west. Darke County is served by U.S. Routes 36 and 127, State Routes 47, 49, 571, and 705, Conrail, and the CSX railroad. The 1980 population of Darke County was reported to be 55,096 (Reference 3).

Darke County is one of the more important agricultural counties in Ohio. Cash grain farming dominated by corn and soybean production is the major agricultural enterprise in the county.

The climate of Darke County is continental, characterized by large seasonal and day-to-day variations in temperature. Summers are moderately warm and humid, with occasional days when the temperature exceeds 90 degrees Fahrenheit. Winters are reasonably cold and cloudy (Reference 4). The average annual precipitation is 36.4 inches. Of the total annual precipitation, about 20 inches usually falls between April and September. Thunderstorms occur about 41 days each year, with half in the summer. Winter precipitation, frequently snow, causes moisture to accumulate in the soil by spring and minimizes drought during the summer. Average seasonal snowfall is 36 inches. The greatest snow depth at any one time was 14 inches. At least 1 inch of snow is on the ground for an average of 22 days (Reference 4).

Although Darke County is predominantly agricultural, residential development is taking place, particularly near the City of Greenville, although not on the scale of that in large metropolitan areas.



FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OH
(UNINCORPORATED AREAS)

APPROXIMATE SCALE

3 0 3 6 9 MILES

VICINITY MAP

2.3 Principal Flood Problems

The majority of the flood problems in Darke County are due to the overflow of Greenville Creek and Swamp Creek. Significant problem areas are located along those creeks in and around the City of Greenville and the Village of Versailles, Ohio. Flood problems are created by a concentration of development susceptible to damage within the floodplains of Greenville Creek and Swamp Creek. Poor natural drainage is the major soil limitation in the flatter areas, and erosion is the major hazard in sloping areas (Reference 5).

2.4 Flood Protection Measures

Flood protection measures are not known to exist within the study area.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

A U.S. Geological Survey (USGS) gaging station with 63 years of record is located on Greenville Creek below the Village of Bradford, Ohio. Floodflow-frequency data at the gage were determined using Bulletin No. 17B (Reference 6). Frequency discharges upstream of the gage were established by square root drainage area proportion. There is no gage on Swamp Creek; the 100-year discharges for Swamp Creek were developed using data from the Greenville Creek gage.

The floodflows on Swamp Creek were determined to be a function of the square root drainage area proportion of the Greenville Creek gage. The determination was verified by examining the magnitude of the relationship between the June 1980 storm that was centered on Versailles and the Swamp Creek basin. That event produced floodwaters that exceeded all previously known elevations for the Swamp Creek basin. A discharge-frequency curve was developed for Swamp Creek and verified using rainfall duration data from Technical Paper No. 40 (Reference 4). The magnitude of flow from the June 1980 storm was determined using actual measurement by the Miami Conservancy District.

Discharge data for the Middle Fork East Fork Whitewater River was determined using the TR-20 computer program (Reference 7).

Peak discharge-drainage area relationships for the 100-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (SQ MILES)</u>	<u>PEAK DISCHARGE (CFS) 100-YEAR</u>
GREENVILLE CREEK		
at Conrail	175	10,340
just upstream of confluence of Dividing Branch	154	9,200
just upstream of confluence of Bridge Creek	142	8,820
just upstream of confluence of Mud Creek	107	7,970
SWAMP CREEK		
at State Route 121	59	5,900
just upstream of confluence of Indian Creek	38	4,750
MIDDLE FORK EAST FORK WHITEWATER RIVER		
at Hill Road	17	5,320
at county boundary	16.4	5,190

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross-section data were obtained from field survey and from detailed mapping developed from aerial photography.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles and on the Flood Insurance Rate Map.

Roughness coefficients (Manning's "n") for the water-surface computations were assigned on the basis of field inspection of the channel and floodplains, and on reproduction of known high-water marks from the June 1980 flood of Swamp Creek and the March 1963 flood of Greenville Creek. Roughness values for Swamp Creek range from 0.05 to 0.07 for the channel and from 0.05 to 0.75 for the overbank areas. Values for Greenville Creek range from 0.04 to 0.06 for the channel and from 0.45 to 0.075 for the overbank areas. Values for the Middle Fork East Fork Whitewater River range from 0.035 to 0.06 for the channel and from 0.065 to 0.12 for the overbank areas.

Water-surface elevations for the 100-year flood were computed using the HEC-2 computer program (Reference 8). Starting water-surface elevations were obtained using the slope-area method. Water-surface elevations for the Middle Fork East Fork Whitewater River were computed using the WSP-2 program (Reference 9). Starting water-surface elevations were taken as the elevations at the confluence with the East Fork Whitewater River.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the map and described in the exhibit labeled Elevation Reference Marks.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations

determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps developed by the COE at a scale of 1:2400 with a contour interval of 4 feet (Reference 10) and by the USGS at a scale of 1:24000 with contour intervals of 5 and 10 feet (Reference 11).

The 100-year floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, A99, V, and VE). Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary was delineated using the Flood Hazard Boundary Map for Darke County (Reference 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways for this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections and are shown in Table 2, Floodway Data. The computed floodways are shown on the Flood Insurance Rate Map. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown. Portions of the floodway for Greenville Creek and Swamp Creek lie within areas not included. Portions of the floodway for the Middle Fork East Fork Whitewater River lie beyond the county boundary.

Along streams where floodways have not been computed, the community must ensure that the cumulative effect of development in the floodplain will not cause more than a 1.0-foot increase in the base flood elevations at any point within the community.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
GREENVILLE CREEK								
A	0.000	491	5702	1.8	985.0	985.0	986.0	1.0
B	0.175	179	2185	4.7	985.9	985.9	986.7	0.8
C	0.435	761	6276	1.6	986.9	986.9	987.8	0.9
D	0.935	381	3338	3.1	988.2	988.2	989.1	0.9
E	1.555	271	2690	3.8	992.7	992.7	993.6	0.9
F	1.685	762	5779	1.8	993.3	993.3	994.2	0.9
G	1.805	756	4661	2.2	993.4	993.4	994.2	0.8
H	2.035	430	2461	4.2	995.6	995.6	995.9	0.3
I	2.675	442	3969	2.6	999.1	999.1	999.7	0.6
J	3.350	501	4757	1.9	1000.2	1000.2	1001.0	0.8
K	4.095	158	1982	4.6	1002.2	1002.2	1003.0	0.8
L	4.247	569	4680	2.0	1002.7	1002.7	1003.6	0.9
M	4.778	637	4844	1.9	1003.1	1003.1	1004.1	1.0
N	5.005	368	2823	3.3	1003.3	1003.3	1004.3	1.0
O	5.251	141	1455	6.3	1004.0	1004.0	1005.0	1.0
P	5.891	144	1544	5.7	1007.6	1007.6	1008.6	1.0
Q	6.217	166	2347	3.8	1009.2	1009.2	1010.1	0.9
R	6.342	450	4058	2.2	1009.5	1009.5	1010.4	0.9
S	6.595	195 ²	2070	4.3	1009.8	1009.8	1010.8	1.0
T	6.726	169 ²	1991	4.4	1010.5	1010.5	1011.3	0.8
U	7.078	140 ³	1832	4.8	1011.8	1011.8	1012.7	0.9

¹MILES ABOVE LIMIT OF DETAILED STUDY (1.53 MILES DOWNSTREAM FROM ARCANUM - BEARS MILL ROAD)

²THIS WIDTH EXTENDS WITHIN AREA NOT INCLUDED

³THIS WIDTH IS WITHIN AREA NOT INCLUDED

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OHIO
(UNINCORPORATED AREAS)

FLOODWAY DATA

GREENVILLE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQ FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
SWAMP CREEK								
A	1.670	213	2551	2.3	965.3	965.3	966.2	0.9
B	1.756	329	3050	1.9	965.5	965.5	966.4	0.9
C	1.911	442	4464	1.3	965.8	965.8	966.7	0.9
D	2.000	341	2988	2.0	965.9	965.9	966.8	0.9
E	3.085	559 ²	4431	1.1	970.5	970.5	971.5	1.0
F	3.307	549 ³	4146	1.1	970.6	970.6	971.6	1.0
G	3.540	403	3125	1.5	970.6	970.6	971.6	1.0
MIDDLE FORK EAST FORK WHITEWATER RIVER								
A	13.330 ⁴	569	2064	2.5	1116.3	1116.3	1116.4	0.1

¹MILES ABOVE MOUTH

²THIS WIDTH EXTENDS WITHIN AREA NOT INCLUDED

³THIS WIDTH IS WITHIN AREA NOT INCLUDED

⁴FEET ABOVE WHITEWATER RIVER

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OHIO
(UNINCORPORATED AREAS)

FLOODWAY DATA

SWAMP CREEK—MIDDLE FORK EAST FORK WHITEWATER RIVER

The area between the floodway and the 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than the state's allowable surcharge at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

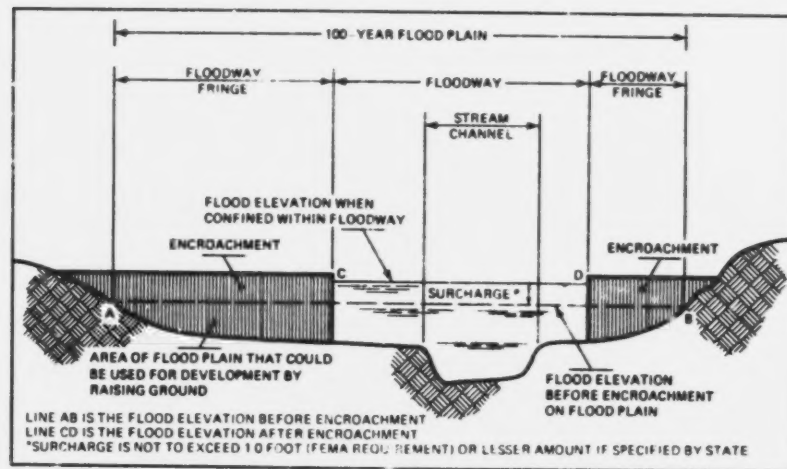


FIGURE 2 - Floodway Schematic

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 100-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than

1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols the 100- and 500-year floodplains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

Flood Insurance Studies published for Wayne County (Reference 1) and Miami, Montgomery, Preble, and Shelby Counties, Ohio (References 12-15) are in agreement with this study.

Flood Insurance Rate Maps printed for the Villages of Ansonia and Gettysburg, Ohio (References 16 and 17) are in agreement with this study.

Flood Insurance Studies in progress for the City of Greenville, the Village of Versailles, and Mercer County, Ohio (References 18-20) are in agreement with this study.

This Flood Insurance Study supersedes the previously printed Flood Hazard Boundary Map for Darke County (Reference 2).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, 175 West Jackson Boulevard, 4th Floor, Chicago, Illinois 60604-2698.

9.0 REFERENCES AND BIBLIOGRAPHY

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10. U.S. Army Corps of Engineers, Louisville District, Topographic Maps, Scale 1:2400, Contour Interval 4 Feet: Darke County, Ohio, June 1987.
11. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Intervals 5 and 10 Feet: Ansonia, Ohio, 1982; Arcanum, Ohio, 1961; Cosmos, Indiana-Ohio, 1960; Dawn, Ohio, 1973; Gettysburg, Ohio, 1961; Laura, Ohio, 1973; New Madison, Ohio, 1973; North Star, Ohio, 1961; Osgood, Ohio, 1980; Rossburg, Ohio, 1961; Spartanburg, Indiana-Ohio, 1960; Union City, Indiana-Ohio, 1960; Versailles, Ohio, 1973; and Whitewater, Indiana-Ohio, 1960.
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15. ———, Flood Insurance Study, Shelby County, Unincorporated Areas, Ohio, September 1982.
16. ———, Flood Insurance Rate Map, Village of Ansonia, Darke County, Ohio, July 1987.
17. ———, Flood Insurance Rate Map, Village of Gettysburg, Darke County, Ohio, January 1985.

18. ———, Flood Insurance Study, City of Greenville, Darke County, Ohio, in progress.
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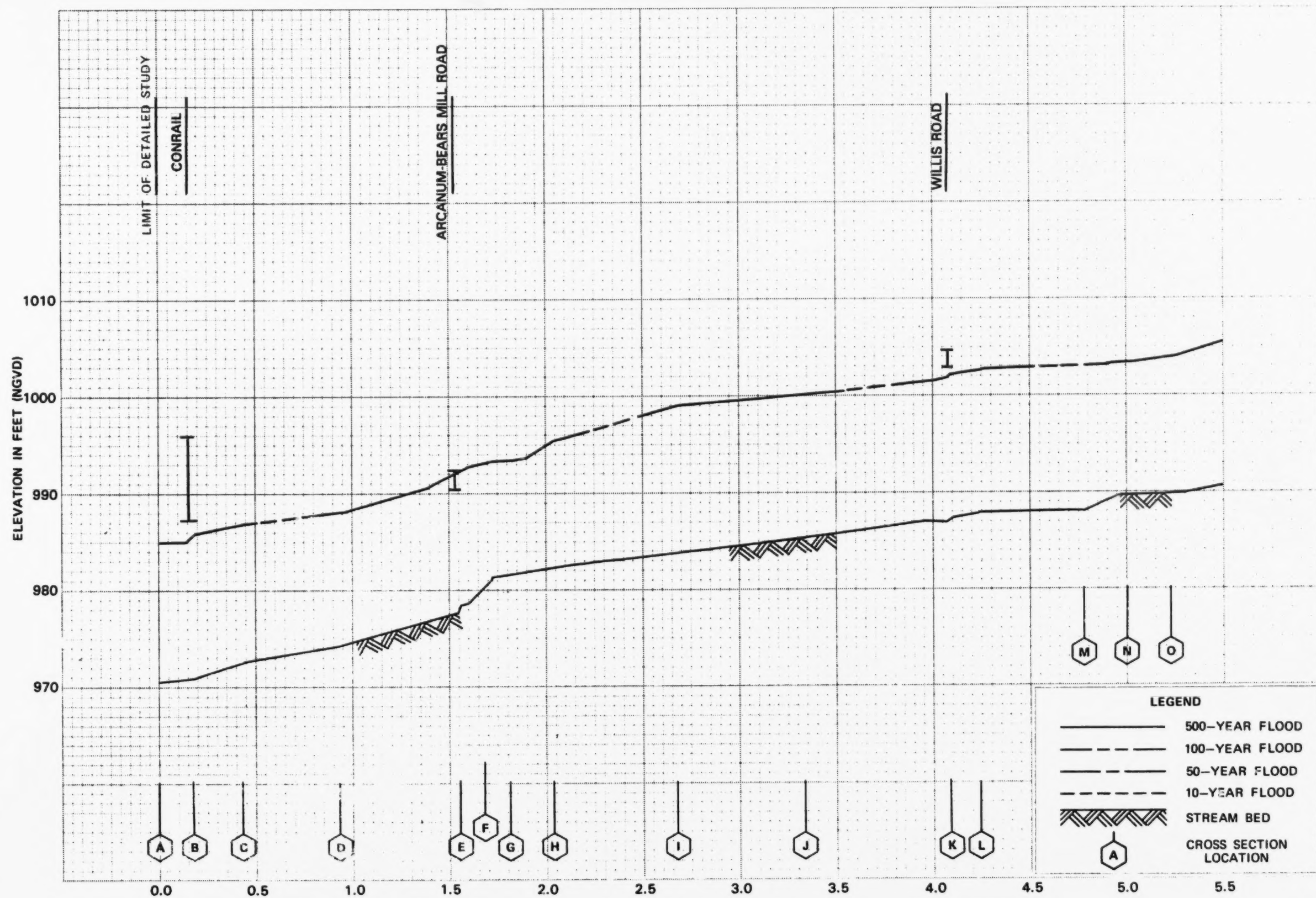
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ELEVATION REFERENCE MARKS

<u>REFERENCE MARK</u>	<u>FLOOD INSURANCE RATE MAP PANEL</u>	<u>ELEVATION (FEET NGVD)</u>	<u>DESCRIPTION OF LOCATION</u>
1	0085	970.01	mark on southeast corner of wingwall located on southeast side of State Route 121 bridge over Swamp Creek
2	0130	992.29	chiseled cross in northwest wingwall of Arcanum-Bears Mill Road bridge over Greenville Creek
3	0130	1,004.55	chiseled square in southeast wingwall of Willis Road bridge over Greenville Creek
4	0130	1,013.77	chiseled square located in southeast wingwall of U.S. Route 36 bridge over Greenville Creek
5	0130	1,018.04	chiseled cross in northeast wingwall of northbound U.S. Route 127 bridge over Greenville Creek



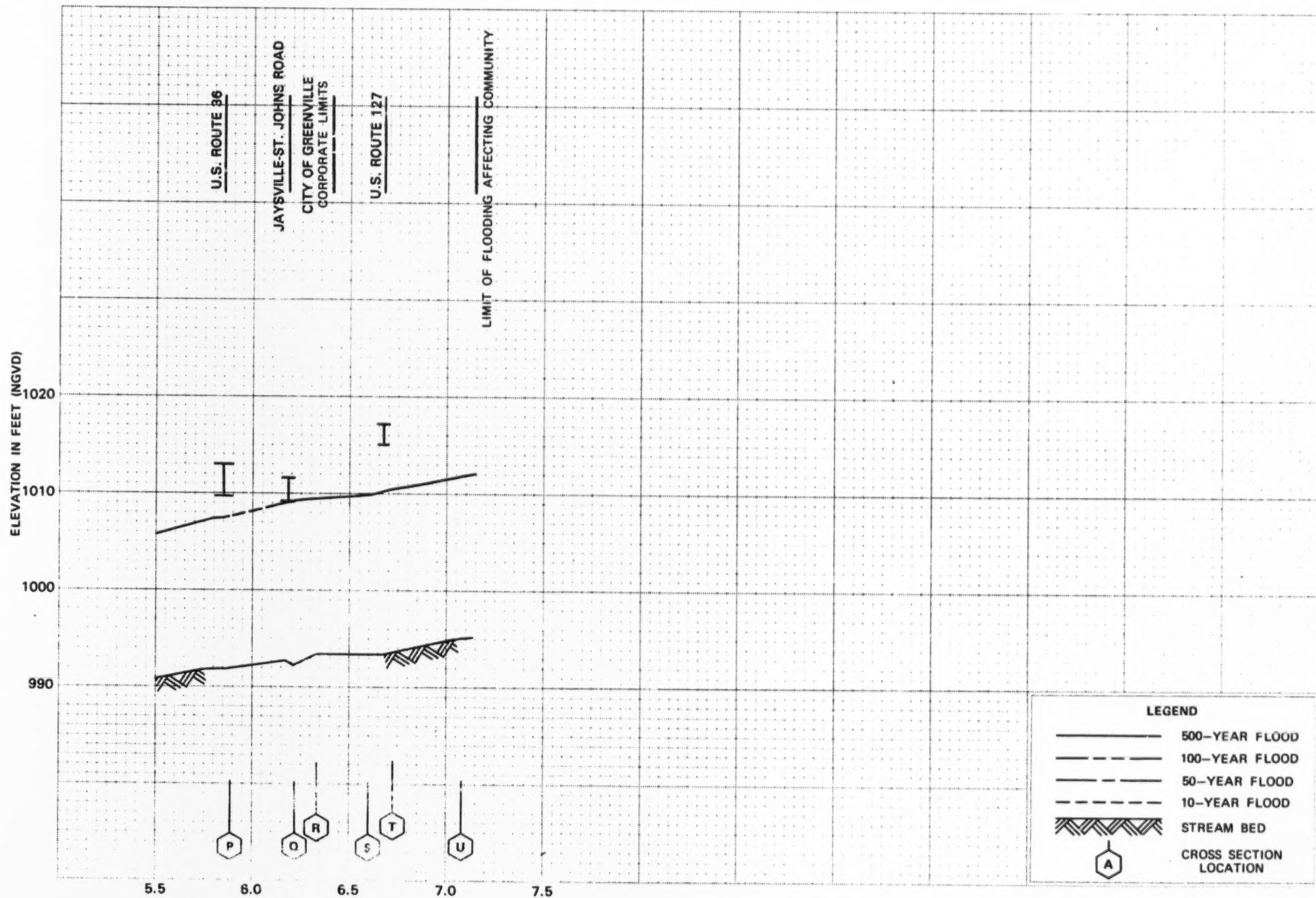
STREAM DISTANCE IN MILES ABOVE LIMIT OF DETAILED STUDY
(LIMIT OF DETAILED STUDY IS 1.53 MILES DOWNSTREAM FROM ARCANUM-BEARS MILL ROAD)

FLOOD PROFILES **GREENVILLE CREEK**

FEDERAL EMERGENCY MANAGEMENT AGENCY
DARKE COUNTY, OH
(UNINCORPORATED AREAS)

01P

15



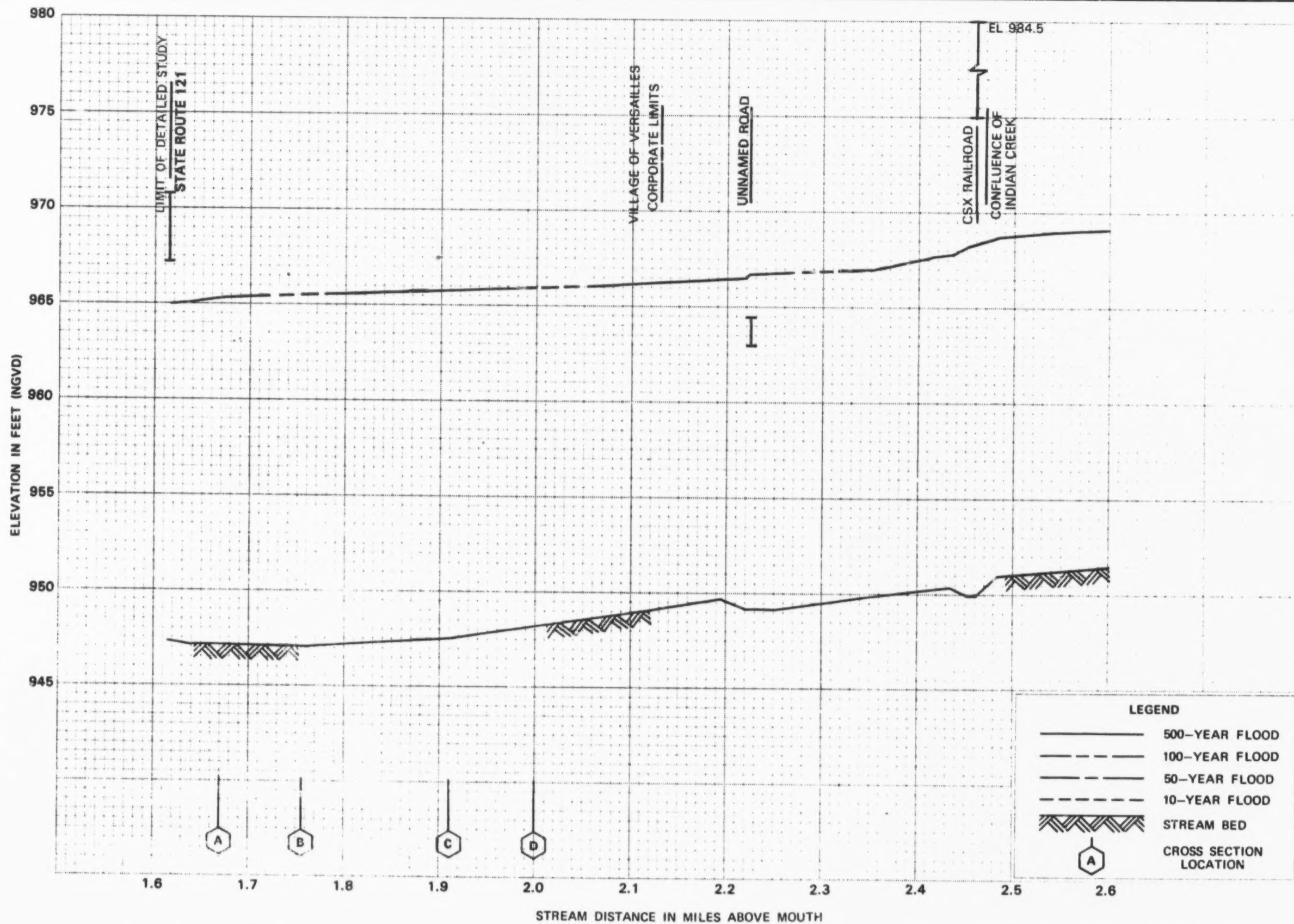
FLOOD PROFILES

GREENVILLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OH
(UNINCORPORATED AREAS)

02P



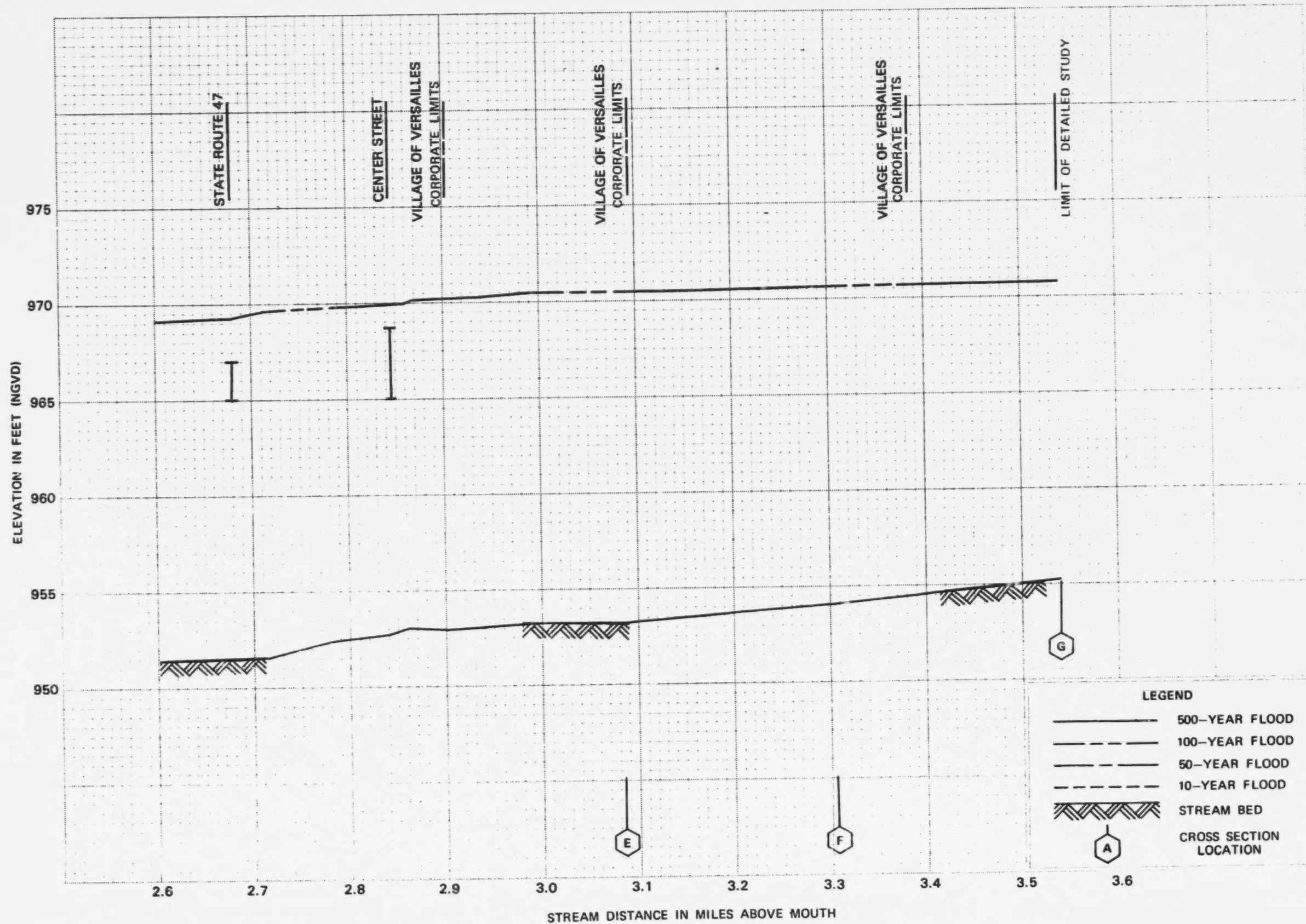
FLOOD PROFILES

SWAMP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OH
(UNINCORPORATED AREAS)

03P



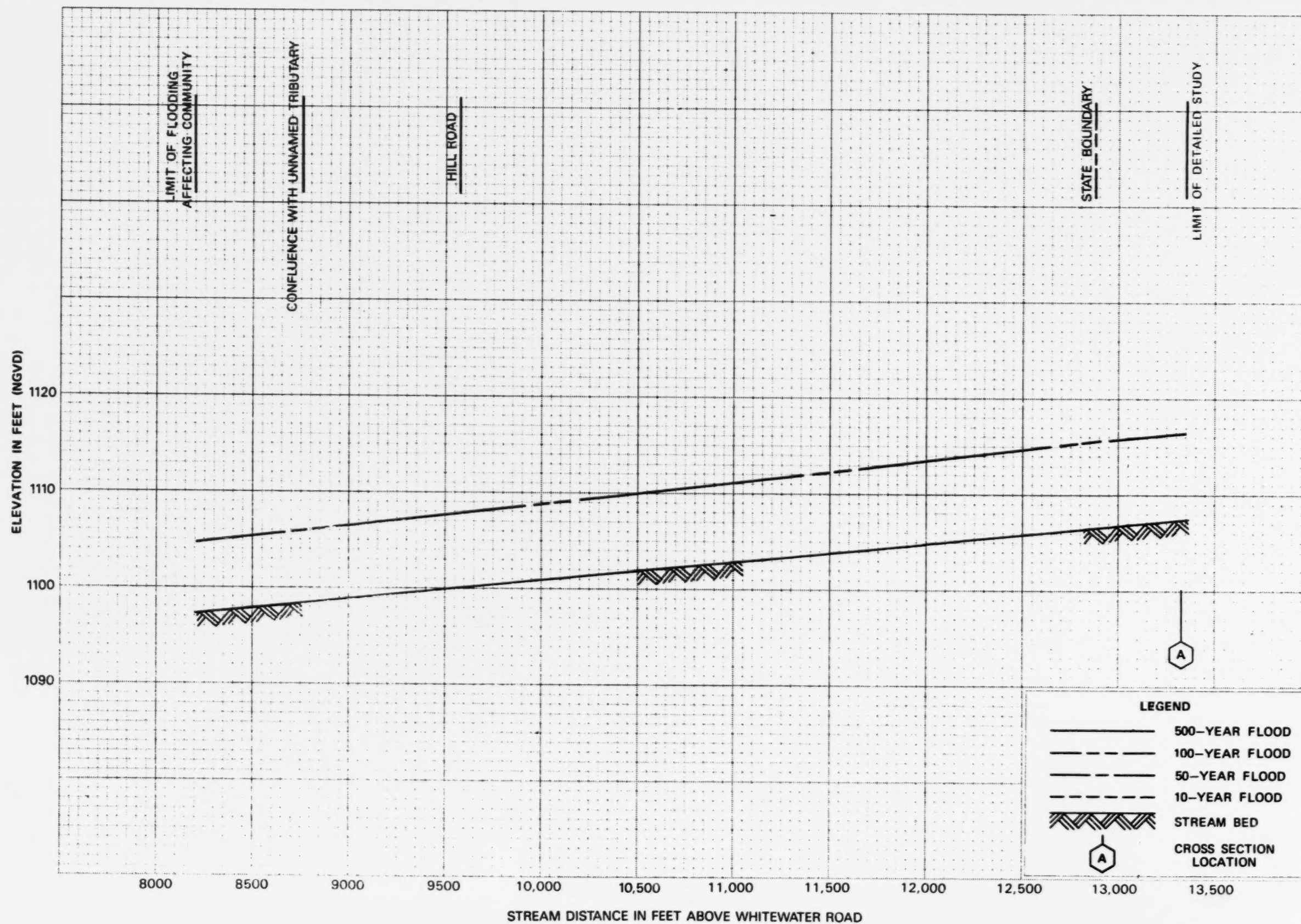
FLOOD PROFILES

SWAMP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OH
(UNINCORPORATED AREAS)

04P



FEDERAL EMERGENCY MANAGEMENT AGENCY

DARKE COUNTY, OH
(UNINCORPORATED AREAS)

FLOOD PROFILES

MIDDLE FORK EAST FORK WHITEWATER RIVER

05P